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ABSTRACT

One hundred thirty-nine college students participated in an experiment designed to examine the basis of their abilities to make relative importance distinctions among ideas in a text while reading. Subjects read two texts of 13 paragraphs each. The topics of the two texts were unrelated, but their topic structure was similar. For each of the critical paragraphs in each text, reading times were recorded for two target sentences: the initial topic sentence and a matched nontopic sentence expressing an idea subordinate to the topic sentence. To test the hypothesis that reading times may have been longer on topic sentences because they contained more new information, two versions of each text were constructed. In one version, the first paragraph of the text did not contain any information about the topics to be discussed. In the second version, the initial paragraph specified the topics of text and their organization. Two kinds of instructions were also given to readers. Half were given a sample outline of the first paragraph of the text before reading the body of the text; the other half read the text straight through, in preparation for a recognition test. The major results of the experiment were that subjects spent nearly half a second more time processing topic sentences than nontopic sentences, and that the magnitude of this "topic sentence effect" depended upon several other variables such as whether the topic sentence effect was greater when the topic sentence introduced a new attribute than when it did not. (HOD)

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ON-LINE PROCESSING OF RELATIVE IMPORTANCE INFORMATION DURING READING

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The ability to discriminate important from unimportant information while reading is one component of skilled reading. This study examines the basis of readers' abilities to make relative importance distinctions among ideas in a text while reading.

There is abundant evidence that readers make relative importance distinctions. It has frequently been observed that subjects remember important information better than unimportant information, both in recall tasks (Johnson, 1970; Kintsch, Kozminsky, Streby, McKoon, & Keenan, 1975; Meyer, 1975; Thorndyke, 1977) and recognition tasks (Caccamise & Kintsch, 1978; Lorch & Lorch, 1983; McKoon, 1977). Further, readers are able to rate the relative importance of text ideas reliably (Eamon, 1978; Kieras, 1982; Winograd, in press). Finally, subjects spend more time reading a phrase or sentence if it contains important information than if it contains unimportant information (Cirilo & Foss, 1980; Lorch & Lorch, 1983). Thus, readers can identify important information in a rapid, on-line manner.

What is the basis of the "levels effect" on reading times? One possible explanation is that important, superordinate statements generally require more processing than unimportant statements if they are to be comprehended. Cirilo and Foss (1980) have suggested that superordinate statements tend to include more information new to the reader than do subordinate statements. This implies that comprehension of superordinate statements would require additional time-consuming operations to represent new information (Haviland & Clark, 1974).

A second explanation of the levels effect on reading times

hypothesizes a strategic component. Cirilo and Foss (1980) proposed that readers can identify important statements while reading and choose to allocate more attention to such statements. A specific version of Cirilo and Foss's hypothesis has been proposed by Lorch and Lorch (1983). They hypothesized that skilled readers construct a representation of the major topics in a text and their interrelationships. When an important statement containing a new topic is encountered, the reader retrieves his or her representation of the topic structure and integrates the new topic. Since such macroprocessing takes time, sentences introducing new topics should and do exhibit relatively long reading times (Lorch & Lorch, 1983).

The present experiment assessed the validity of these two accounts of the levels effect on reading times. Because these accounts are not competing hypotheses, the experimental design allowed for the possibility that readers might both respond strategically and require more time to integrate the new, important information. Subjects read two texts of 13 paragraphs each. The topics of the two texts were unrelated, but their topic structure was similar. The last 12 paragraphs of both texts discussed six attributes of each of two major topics. The presentation of topics was ordered by attributes. For example, in a text discussing attributes of the fictional countries Morinthia and Culatta, first the geography of Morinthia was discussed, then Culatta's geography was described. Next, the climates of Morinthia and then Culatta were discussed, and so on. For each of the 12 critical paragraphs in each text, reading times were recorded for two target sentences: the initial topic sentence and

a matched nontopic sentence expressing an idea subordinate to the topic sentence. We have previously observed that subjects read the topic sentences more slowly than the nontopic sentences of these texts. Our primary interest in this experiment was how this "topic sentence effect" would depend upon two other experimental manipulations.

To test the hypothesis that reading times may have been longer on topic sentences because they contained more new information, two versions of each text were constructed. In one version, the first paragraph of the text did not contain any information about the topics to be discussed. In the second version, the initial paragraph specified the topics of text and their organization. Thus, the subjects of the topic sentences were new to readers receiving the uninformative first paragraph, but were old concepts to subjects receiving the informative paragraph. If the first hypothesis is correct, the topic sentence effect should be smaller when an informative paragraph is provided than when an uninformative paragraph is provided.

To test the hypothesis that readers optionally choose to allocate more attention to topic sentences than to nontopic sentences, two kinds of instructions were given to readers. Half gave a simple outline of the first paragraph of the text before reading the body of the text; the other half read the text straight through in preparation for a recognition test. It was expected that subjects who outlined the first paragraph would be more sensitive to topic information in their subsequent reading than subjects who did not outline. Given this assumption, if the second hypothesis is correct the magnitude of the topic sentence

effect should be greater for outliners than for non-outliners.

Method

Subjects

A total of 139 subjects participated in the experiment, but the data of 11 subjects were discarded because of computer malfunctions or failure of the subject to follow instructions. All subjects were volunteers from introductory psychology classes at the University of Kentucky and received credit for experimental participation.

Materials

Two practice texts and two experimental texts were constructed for the experiment. The experimental texts were written on different topics. One discussed two fictional countries (Countries text) and the other was about chimpanzees and orangutans (Apes text). The texts had similar structures, but different content. Each text consisted of 13 paragraphs. The first paragraph of both texts served as an introduction to the remainder of the text. The remaining 12 paragraphs of each experimental text discussed six attributes of each of two major topics. The Countries text discussed the geography, climate, exports, imports, people, and politics of two fictional countries, Morinthia and Culatta. The Apes text discussed six attributes of each of two types of apes, chimpanzees and orangutans.

For each of the 12 critical paragraphs of each text, two target sentences were constructed. One, the "topic sentence," was always the initial sentence of the paragraph. It introduced the next text topic and asserted a general property of that topic which was elaborated in the remainder of the paragraph. For each

topic sentence, a second "nontopic sentence" was constructed. The nontopic sentence was approximately equated in length to the topic sentence and the conveyed information subordinate to the information contained in the topic sentence. All target sentences were less than 64 character spaces long (the line length of the display screen on which the texts were presented).

Given the attribute organization of the text, half of the target sentences came from paragraphs introducing a major shift of topic (i.e., the country and attribute changed) and half of the sentences were embedded in paragraphs introducing a minor shift of topic (i.e., only the country changed). Two versions of the experimental texts were written which differed in the order of the presentation of the countries. The purpose of this manipulation was to counterbalance the assignment of target sentences to levels of the Topic Shift variable.

Finally, for each version of each text, two different introductory paragraphs were written. One introductory paragraph was only generally related to the body of the text (Uninformative paragraph). This paragraph gave the reader some warm up without providing information about specific topics. The other introductory paragraph stated the text topics and the order in which the topics would be discussed (Informative paragraph).

Eight different sets of four texts each were constructed. The first and third texts in each set were always the same practice texts. The eight sets represented all possible combinations of three counterbalancing variables: assignment of texts (Countries or Apes) to the Introductory Paragraph conditions; order of presentation of the two Introductory

Paragraph conditions; and assignment of major topics to levels of the Topic Shift variable.

For the verification task, 24 sentences were constructed for each experimental text. Half of the sentences were true and half were false; half tested memory for superordinate information and half tested memory for subordinate details. The true sentences were paraphrases of sentences from the text; the false sentences contradicted statements from the text. All sentences were less than 64 character spaces long and superordinate and subordinate statements were approximately equated in length. The verification sentences were the same for all versions of the same text. Verification sentences were also constructed for the two filler texts.

Procedure

Subjects participated individually in the experiment. An experimental session generally lasted between 40 and 80 minutes. A TRS-80 Model 1 microcomputer controlled the execution of the experiment: It presented instructions, texts, and verification sentences and it recorded all responses by the subject.

Subjects read and were tested on four texts. Each text was presented a sentence at a time. Each sentence was presented left-justified, in capital letters, at the same horizontal location on the screen. Paragraph boundaries were not physically marked (e.g., no indentation). Pressing the space-bar on the computer's keyboard caused the current sentence to be erased immediately and the next sentence to appear after a delay of approximately 1 second. Reading time was measured from sentence presentation until the next press of the space-bar. Reading times

were measured with a resolution of approximately 9 milliseconds. Subjects were encouraged to read at a normal, comfortable pace.

After each text, instructions were given for the verification task. Subjects were informed that they would be presented sentences one at a time. For each sentence, they were to judge whether it was a true or false statement based on their reading of the text. Subjects responded "true" or "false" by pressing the "T" or "F" key on the teletype, respectively. Reaction times were recorded with a resolution of about 14 milliseconds. The instructions emphasized both speed and accuracy. The order of presentation of the sentences was randomized independently for each subject. Subjects were given feedback for each response. If a subject took more than 7 seconds to respond, the message "Too Slow" was displayed. Feedback messages ("Correct", "Error", "Too Slow") were presented for a duration of approximately 840 milliseconds; the interval between erasure of the feedback and presentation of the next sentence was approximately 2.25 seconds.

After the last sentence of the first verification task was presented, subjects were given refresher instructions for the reading task and told to begin when ready. The procedure continued to alternate between the reading and verification tasks until all four texts were read and tested.

Subjects were assigned at random to the Outline and No Outline conditions. Subjects in both conditions performed the reading and verification tasks as described above. In addition, subjects in the Outline condition were asked to provide an outline of the initial paragraph of the Countries and Apes text before reading the texts. When the first experimental text was about to

be presented, these subjects were given the introductory paragraph of the experimental text and instructed to "write an outline of what you think the text will be about based on the paragraph." They were given an example of an appropriate, two-level outline and any questions they had were answered. The introductory paragraph was presented in its entirety and was available to the subjects until their outlines were completed. Although the Uninformative paragraphs gave no useful information regarding the topics of the upcoming text, all subjects performed the outlining task in this condition without objections. After the outline was completed, the subject performed the reading task beginning with the first sentence of the introductory paragraph. Outlines were produced for both experimental texts, but not for the two filler texts.

Results

Analyses of Reading Times

A mixed factors, fixed effects ANOVA was conducted on the reading times. The between-subjects factors in the ANOVA were Instructions (outline or no outline) and the three counterbalancing variables. The within-subjects factors in the ANOVA were: Sentence-type (topic or nontopic); Type of Topic Shift (minor, within-attribute shift vs. major, between-attribute shift); and Introductory Paragraph (informative or uninformative). All *F*-tests are based on 1 and 112 degrees of freedom unless otherwise indicated and all reported results are significant at the .05 level unless otherwise indicated.

Table 1
Mean Reading Times (in seconds) as a Function of Condition

	No Outline Condition			
	Uninformative Paragraph		Informative Paragraph	
	Major Shift	Minor Shift	Major Shift	Minor Shift
Topic	2.976	2.659	2.804	2.498
Nontopic	2.445	2.278	2.284	2.316
Difference	.531	.381	.520	.182

	Outline Condition			
	Uninformative Paragraph		Informative Paragraph	
	Major Shift	Minor Shift	Major Shift	Minor Shift
Topic	3.226	2.772	3.092	2.537
Nontopic	2.383	2.274	2.352	2.253
Difference	.843	.498	.740	.284

The reading time results are summarized in Table 1. The most important observations in the experiment concern the topic sentence effect. First, reading times to topic sentences were an average of .497 seconds slower than reading times on nontopic sentences, F=170.25, MSe=2.235. Second, although the topic sentence effect was consistently large, its magnitude varied as a function of several other variables. The topic sentence effect was smaller in texts that began with an informative introductory paragraph (.402 second effect) than in texts that began with an uninformative introductory paragraph (.563 second effect), F=7.08, MSe=.945. This effect of the introductory paragraph was restricted almost entirely to topic sentences: The effect of the introductory paragraph on topic sentences was .175 seconds, while the effect on nontopic sentences was only .044 seconds. The topic sentence effect was larger for subjects who outlined the introductory paragraph (.591 second effect) than for subjects who did not outline (.404 second effect), F=6.07, MSe=2.235. Again, there was a large effect of instructions on reading times to topic sentences (.172 second effect), but virtually no effect for nontopic sentences

(.015 second effect). Finally, the topic sentence effect was larger for paragraphs in which the attribute shifted from the preceding paragraph (.659 second effect) than for paragraphs in which the attribute did not shift (.356 second effect), F=41.06, MSe=.970. Once again, the topic shift effect was large for topic sentences (.408 second effect), while there was little effect on the nontopic sentences (.086 second effect).

One other result was observed in the overall analysis. Subjects who outlined the introductory paragraph were influenced more by the Topic Shift manipulation than subjects who did not outline, F=5.01, MSe=.994. Subjects who outlined read the sentences of the major shift paragraphs .305 seconds slower than they read the sentences of the minor shift paragraphs, while the effect for subjects who did not outline was .170 seconds.

Analyses of Verification Results

Mixed factors, fixed effects ANOVAs were conducted on the reaction time and error data from the verification tasks. In both analyses, the between-subjects factors were the same as those for the reading time analyses (i.e., Instructions and three counterbalancing variables). The within-subjects factors were: Introductory Paragraph (informative or uninformative); Hierarchical Level (superordinate or subordinate fact); and Truth-value (true or false). The data from one subject were unavailable because of computer malfunction. All statistical tests were based on 1 and 111 degrees of freedom. Errors and times longer than 7 seconds were excluded from the reaction time analysis (13.65%). Times longer than 7 seconds were included in the error analysis.

Table 2
Mean Reaction Times and Percentage Errors (in parentheses) as a Function of Condition for the Verification Task

		Introductory Paragraph					
		Uninformative Paragraph			Informative Paragraph		
		True	False	Mean	True	False	Mean
Level	High	2.214 (16.80)	2.390 (13.12)	2.302 (14.96)	2.339 (9.71)	2.399 (10.11)	2.369 (9.91)
	Low	2.370 (14.17)	2.476 (15.38)	2.423 (15.03)	2.414 (15.35)	2.452 (14.04)	2.433 (14.70)
	Mean	2.292 (15.49)	2.433 (14.50)	2.363 (15.00)	2.377 (12.53)	2.426 (12.08)	2.401 (12.31)

The results for the verification task are summarized in Table 2. Since there were no effects of Instructions in either analysis, the data have been collapsed over the two instructional conditions. First, there was a levels effect for both the reaction time and error data. Subjects were .093 seconds faster to respond to statements about important than unimportant information, F=25.50, MS_e=.087. In addition, subjects made 2.43% fewer errors on important statements than on unimportant statements, F=9.38, MS_e=.522. Readers also made 2.69% more errors after reading a text with an uninformative, rather than informative introductory paragraph, F=9.27, MS_e=.752. The levels effect and the effect of the introductory paragraph on errors were qualified by two interactions. First, the levels effect was larger for texts with an informative introductory paragraph (4.79% effect) than for texts with an uninformative introductory paragraph (.07% effect), F=6.33, MS_e=.857. Further, there was a Level x Paragraph x Truth-value interaction indicating that the levels effect was reversed for true sentences in the uninformative condition, F=4.39, MS_e=.691.

There were two other reliable effects. First, subjects

responded faster to true statements than to false statements, $F=24.50$, $MSe=.099$. Second, the effect of truth-value was greater for the uninformative paragraph condition (.141 seconds) than for the informative paragraph condition (.049 seconds). However, it should be noted that both of these findings may be at least partially attributable to a speed/accuracy tradeoff.

Discussion

The major results of the experiment were that subjects spent nearly half a second more time processing topic sentences than nontopic sentences, and that the magnitude of this "topic sentence effect" depended upon several other variables. Specifically: (1) The topic sentence effect was smaller if the introductory paragraph of the text informed the reader of the topics and their organization than if the introductory paragraph was uninformative. (2) The topic sentence effect was larger for readers who outlined the introductory paragraph than for readers who did not outline the paragraph. (3) The topic sentence effect was larger when the topic sentence introduced a new attribute than when it did not. It should be emphasized that the nature of all three of these interactions was that the variables only affected reading times to topic sentences; none of the variables influenced reading times on nontopic sentences.

Let us consider the implications of these results.

Evaluation of Hypotheses

One hypothesized basis for the topic sentence effect was that topic sentences typically contain more new information than nontopic sentences (Cirilo & Foss, 1980). Since it takes time to construct memory representations for any new information in a

sentence, the time required to comprehend a sentence should depend upon the amount of new information it contains (Haviland & Clark, 1974). In the present study, the amount of new information in the topic sentences was varied by manipulating the introductory paragraph of the two experimental texts. The finding that topic sentences were read faster if the introductory paragraph was informative rather than uninformative thus supports the hypothesis that the topic sentence effect depends partly upon differences in the amount of new information conveyed by topic versus nontopic sentences. This result provides further support for the "given-new" strategy (Haviland & Clark, 1974). It is consistent with previous findings demonstrating the relevance of the given-new strategy as a model of microprocessing during processing of text (Graesser, Hoffman, & Clark, 1980; Lesgold, Roth, & Curtis, 1979).

The second hypothesis tested by the experiment was that readers spend relatively more time processing topic than nontopic sentences because they recognize the importance of the topic sentences and choose to devote more processing to them (Cirilo & Foss, 1980). This hypothesis was tested by manipulating the tasks that subjects performed on the texts. It was reasoned that subjects who were required to outline the introductory paragraph of the texts would perceive topic sentences as more relevant to their reading than would subjects who were not required to outline. Therefore, outliners were expected to spend more time processing topic sentences than non-outliners. This prediction was confirmed. The magnitude of the topic sentence effect was 46 percent greater for outliners than for non-outliners. Experienced

readers evidently can identify important information quickly enough to make an on-line decision to allocate additional attention to that information. It is interesting to speculate whether the processes underlying this ability are independent of those associated with the given-new strategy (Kintsch & van Dijk, 1978). There is some weak support for such speculation in the finding that there were independent effects of the Instructions and Introductory Paragraph variables.

A third basis for the topic sentence effect may be identified. Lorch and Lorch (1983) have proposed that experienced readers construct a representation of the major topics of a text and their interrelationships. They hypothesized that whenever readers encounter a major shift of topic while reading, they retrieve a representation of the topic structure and integrate the new topic into that representation. According to this model, the time it takes to process a topic sentence should depend upon how difficult it is to integrate the new topic into the reader's representation of the topic structure. The model is supported by the finding that reading times were slower on topic sentences that involved a shift of attributes than on topic sentences that did not shift to a new attribute (Lorch & Lorch, 1983; present study). Thus, part of the time required to process a topic sentence reflects processing of the text's topic structure.

In sum, the present study has identified three distinct contributions to the topic sentence effect. The time it takes a reader to process a topic sentence depends upon the amount of new information the sentence contains, the ease with which the new topic can be related to previous topics in the text, and the

relevance of the sentence to the reader's goals. These findings support both of Cirilo and Foss's (1980) suggestions concerning the basis of the levels effect on reading times. Specifically, to the extent that important statements in a text contain more new information than unimportant statements, they will take longer to comprehend. Further, readers can choose to devote more attention to important statements if such a strategy fits their purposes.

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